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Enhancing US Security by Modernizing USMA Education with Modeling and Complexity Science

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Abstract

Given the complex nature of the contemporaneous security environment, we discuss the importance of preparing future officers for their roles in helping to solve challenging and complicated problems. We argue that a reductionist approach to problem-solving is no longer sufficient for the challenges of this century. Rather, the problem-solvers of today and tomorrow should incorporate complexity science into their methods and models. Just as West Point served as a national leader in modernizing the content and pedagogy of technical post-secondary education in the 19th century, we argue that West Point should take the lead in helping to modernize post-secondary education in this century. We conclude by encouraging today's instructors to begin incorporating complexity analysis into their classrooms.

1 Introduction

The global security environment is changing at an incredibly fast pace. The US military has new operational missions on battlefields and in environments that did not exist before this century. Moreover, the types of missions and the environments in which the military operates evolve faster than the military can modify its formal doctrine or adjust its traditional resource acquisition and allocation systems. Consequently, leaders, at all levels, are increasingly less likely able to rely on specific, detailed, routine, or algorithmic processes or procedures while executing missions. Faced with this rapid dynamism, the US requires, more than ever, that its military leaders possess the ability to think critically, demonstrate mental dexterity, and solve difficult, multi-faceted problems in order to effectively make decisions and apply resources in support of intent-driven objectives. In an era of complex insurgencies and hybrid wars, shape-shifting and ill-defined enemies, and cross-cultural and inter-tribal friction, it is critical that military leaders at all levels are able to construct and navigate a wide range of strategic and tactical pathways to informed decision making. As such, cadets (and officers) must have opportunities for measured, reflective, and intellectual study and discourse to reinforce and grow their military science knowledge and professional leadership skills because we need leaders with military, science, and cultural knowledge as well as the ability to solve technical problems and to confront social issues. Therefore, we seek to develop genuine scholar-warriors who merge their experience and skill with a deep intellectual understanding of military complexity and the ability to use interdisciplinary modeling to analyze complex situations. By using the tenets of modern military operations and state-of-the-art methods of information and complexity science, future officers will be prepared for global situations and events that necessitate military operations.

Our world is full of diverse and integrated systems, people, organizations, governments, and networks with varied actions and behaviors that produce complex situations. In todays world, it is not unusual to have security threats that involve political uprisings, market crashes, economic crises, information cascades, and new social trends. People who solve and analyze problems and issues using modeling and inquiry gain insights into the behavior of these complex phenomena. Modeling, which we define as the iterative process of developing and refining abridged representations of real-world phenomena, helps people think more critically about problems because models help people process and organize information, make sense of both data overload and data scarcity, and focus effort on the important elements of the problem or issue. Further, modeling improves the ability to explain problems, design and formulate strategies for solving problems, make decisions about which strategy (or strategies) to pursue and which resources to allocate toward solving problems, and also to predict the range of possible outcomes. Inquiry, which we define as deliberate, thoughtful examination of a problem and assessment of potential solution strategies, enables people to develop deeper knowledge of the problem scope and solution space as well as to enter more innovative modes of thought. We argue that effective modeling and inquiry skills are essential operational requirements of the modern military leader.

Thomas Kuhns *The Structure of Scientific Revolutions* (1962) explained how the advancement of human knowledge and culture are not orderly processes. Rather, advancements are made as the result of disordered, complex interactions of people and the ideas they generate in the search to find new paradigms that better describe reality. A paradigm is an archetypical framework, consisting of a combination of rules, cultural values, knowledge, and processes, which we use to reason and make decisions. We live with a paradigm until we discover a problem or set of problems that cause us to experience a crisis in our observed reality. As we attempt to better understand our new perception of reality, we often update our rules and values, generate new ideas and new knowledge, and modify our processes resulting in the creation of a new, and hopefully more useful, paradigm.

The US military is experiencing a shift in paradigms as it works to create a way to cope with the evolving security environment while advancing its operational capabilities. Complicating matters is the deluge of information now available to the military as a result of advances in sensor technology, computing power, communications inter-connectivity, and data generation mechanisms. While the military is engaged in paradigm shift with respect to the way it makes decisions, allocates resources, and executes missions, we observe the world engaged in global paradigm shift at several different levels including ways in which individuals interact with other individuals, businesses, and government entities. In todays world, businesses interact locally and globally, and governments interact with other governments as well as non-governmental, trans-national actors. Further, these global paradigm shifts are occurring in the presence of turmoil, confrontation, and anxiety.

For centuries, reductive quantitative modeling produced steady progress in the physical sciences. Methodological reductionism is the attempt to provide an explanation of complicated phenomena in terms of smaller entities.[1]See Figure **??**. It is the attempt to explain entire systems in terms of their individual, constituent parts combined with a final step of attempting to describe the linkages between sub-components or sub-systems. For example, one might attempt to explain the actions of a soldier in battle by first, and separately, using discipline-specific analysis to explore the soldiers physical well-being, psychological state, information processing capabilities, and contextual environment, and then attempting to construct an overall assessment by loosely linking the pieces of the micro-studies together. The reductive approach to problem-solving tends to initially present a subject or problem in simplified form, especially one potentially viewed as crude, and then iteratively adds layers of complexity as the pre-cursor, simple forms are solved. In essence, the reductionist explains phenomena completely in terms of fundamental components, and to subscribe to reductionism implicitly means the acceptance of the assumption that a system is composed entirely of its parts. However, systems often have features that none of its parts have. Different levels of organization of constituent parts often have their own unique properties that result not as the sum of parts but rather as a by-product of non-smooth, non-linear interactions of parts. That is, complex systems may have properties that are not reducible to or deductible from the properties of its constituent parts. As such, it is often limiting or short-sighted to view modern, complex systems as reducible.

Complex phenomena have multiple interacting components, with emerging behavior that is entailed by, but cannot be immediately inferred from, the dynamics of its component parts, as would be the case using reductionist descriptions. The nonlinear interactions generate a blend of regular and erratic variability in complex phenomena, which enable them to adapt to a changing environment. See Figure **??**, which is a chart from a Mad Scientist presentation given by Bruce West and Chris Arney on December 6, 2017. The modern world and its problems contain many forms of complexity: different and possibly contradictory views by different stakeholders (hybrid); corrupted, uncertain, or missing data (hidden and dark networks); multiple and varied ideological and cultural constraints (lack smoothness and proportionality); rapidly changing political and economic constraints (dynamic); numerous possible intervention points (erratic); considerable uncertainty and ambiguity in assumptions (stochastic); and randomness or fog of war (chaotic). These complexities (will) characterize the essence of (future) military operations. Instead of relying solely on reductionist approaches to explain and understand the systems and complexities of modern (and future) security-related issues and problems, contemporaneous analysis needs to embrace complexity and the scientific search for explanations and properties of systems at the system level.

Qualitative modeling and complexity science emerged in the 20th century to confront the more complex phenomena in the social, behavioral, and military sciences. The conception of

[1]There are several sources that discuss variations of the concept of reductionism including, among others,*The Oxford Companion to Philosophy* (Michael Ruse, 2005), *Interdisciplinary Encyclopedia of Religion and Science* (John Polkinghorne, 2002), and *Reductionism: Analysis and the Fullness of Reality* (Richard H. Jones, 2000).

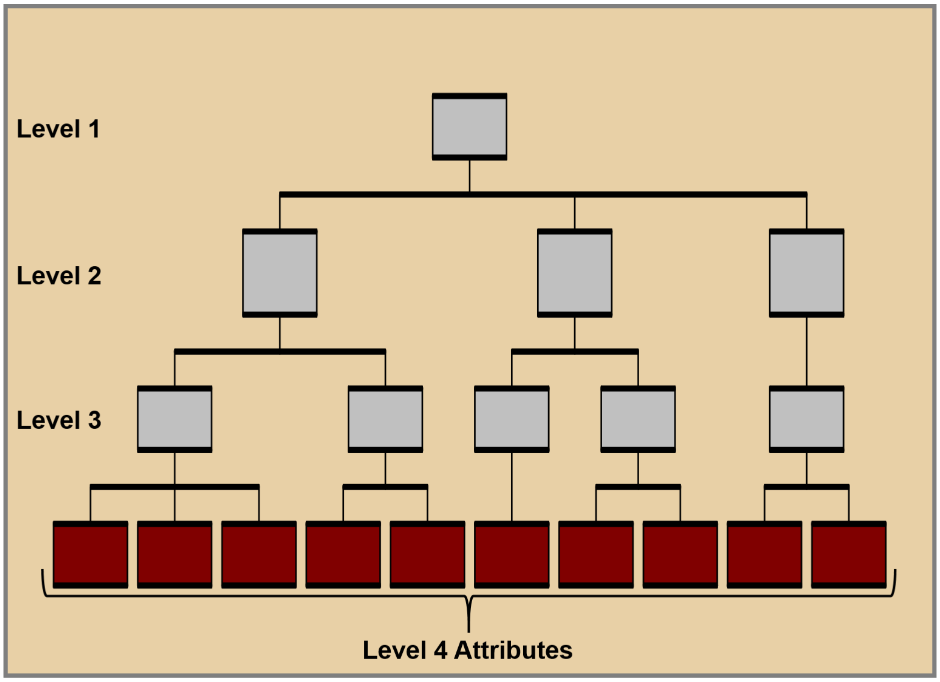

Figure 1: A view of reductionism: describing complex level 1 phenomena by breaking the problem into constituent parts then piecing back together insights gleaned only using information from the lowest level.

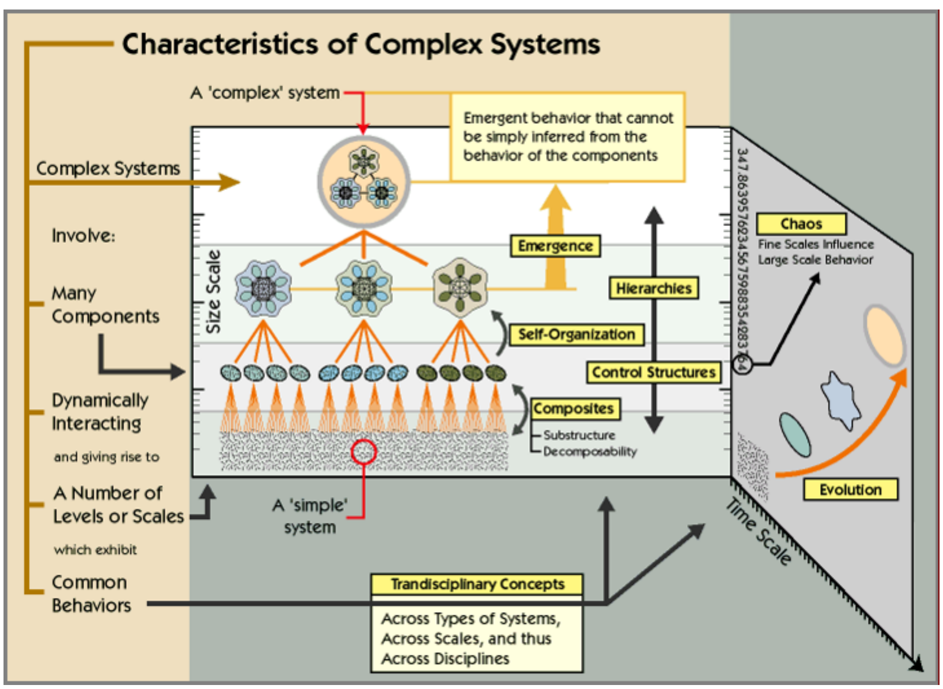

Figure 2: A view of a complex system, showing some of the possible relationships and characteristics.

complexity science is to use non-reductive models to dovetail the quantitative and the qualitative elements of problems. Through several major paradigm shifts of society during the twentieth century, significant information-based and military-relevant scientific disciplines developed including operations research, decision science, information science, computer science, data science, network science, and cyber science. Working within these disciplines, modelers found the traditional reductive approach limiting for many of the most cogent and capricious problems of the 21st century. Instead, practitioners in these disciplines began to incorporate complexity modeling and analysis as a core feature of their discipline-specific scientific-process methods. The new paradigm of complexity science, with its inherent foundation of non-reductive modeling, has changed the principles of military operations.

2 Modernizing the US Military

The US military is a highly-structured, hierarchical institution that operates complicated industrial age technological systems. The US government often gives its military highly complex missions in this post-industrial, Information Age world. Examples of contemporaneous mission declaratives include modernize Afghanistan, develop African security and cooperation, keep peace in the Middle East, cure Ebola in Africa, deter North Korea and other aggressive nations, and stop piracy along the African coasts. To prepare for success in these missions, the military needs to be revamped and modernized from private to general, from pistol to drone, from submarine to satellite, from basic training to the war college, and from admission to graduation at the militarys service academies. The currently outdated version of the US military, even with more money, advanced technology, improved logistical facilities, and costly material resource improvements, cannot accomplish these modern complex missions without a more competent and knowledgeable workforce with more mental dexterity, critical thinking ability, and depth in the diversity of skills. Leadership improvement needs to start with a new intellectual mantra at the service academies and other military schools that includes embracing the complexity of the modern information age world. The military, like other modern organizations, needs a paradigm shift to take on its complex tasks by identifying its problems and issues, generating viable solutions, building realistic models, developing actionable plans, and upgrading methods for testing, validating, and implementing those plans. All these elements have impactful complex components, which is to say that the reductive-style models of the past, that is models which tend to over-simplify problems and attempt to fit them into uniform representations, are no longer adequate for modern military leaders. Enhancing and modernizing service academy education can jump-start the building of a paradigm shift that can better enable future military operational success.

Full-spectrum operations (or Multi-Domain Battle[2]) in the modern information environment requires military forces to incorporate and exploit complexity methodology in the forms of network-centric warfare, mission command, and multi-domain doctrine. The US military cannot rely solely on new technological developments such as artificial intelligence (AI), autonomous vehicles, and robotic warriors. Leaders must integrate the multiple capabilities of highly-capable forces with advanced technological systems to obtain operational advantage.

We need astute thinking by leaders and service members, enhanced use of information and data science, appropriate use of complexity modeling, and modern exploitation of media to communicate and collaborate in order to achieve success. Military information processing such as improving Observe, Orient, Decide, Act (OODA) loop decision making, developing data-to-decision systems, and incorporating grey zone thinking will play significant roles in modern force capabilities.

Smart, defined as the ability to learn, and knowledgeable, defined as having access to relevant information, are advantages for any kind of system whether physical, informational, social, biological, or hybrid. Together, smart and knowledgeable can create intelligence, defined as the ability to apply knowledge and skills, that drives the design, planning, execution, and sustainability of effective military systems and operations. The militarys ability to tailor forces, communicate over long distances, achieve dynamic coordination of operations, manipulate and exploit enemy weaknesses, and effectively employ kinetic and psychological warfare tactics are based on networked systems that give leaders and their service members the situational awareness to succeed. Combining and integrating appropriate joint, coalition, and specialized forces capable of amplifying the others produces a resulting force that is greater than the sum of its parts, agile, and capable of achieving success.

Modern wars are fought between the intellects of the people who compose the opposing forces and their respective leaders through confrontations of each sides personnel, materiel, and operational systems. This holds true for nations, non-state actors, and insurgent groups. Effective operation of systems-of-systems with their networks of informational, social, and physical layers enable the military to deal with determined adversaries and adverse environmental factors. Understanding the complex nature of modern systems-of-systems is important for leaders and implementers of network-centric doctrine. The necessary agility of a force is forged from connecting systems of communication, networking of sensors, automating intelligence systems, identifying high-value targets, informing decision makers, and effectively employing appropriate weapons systems. The results of the efforts are shared situational awareness, increased speed of command and control, higher tempo of operations, greater lethality of weapons, increased survivability, and powerful synchronization of action. These enhanced capabilities create an improved ability to sustain operations while maintaining rapid operational speed. Having the ability to make decisions and act faster than the enemy (OODA loop performance) are the foundation of modern military operations that produce favorable conditions for US forces.

Warfare of the future will need its operational planning, intelligence collection, and decision-making to happen simultaneously with kinetic action. Networking is the key enabler for battlespace speed and thus critical for operational success. To facilitate effective network-

[2]Multi-Domain Battle is a relatively new concept, introduced by the Armys Training and Doctrine Command in 2017, that describes a coordinated US Army and US Marines approach for combined arms in the 21st Century. Multi-Domain Battle addresses the challenges posed by sophisticated peer adversary threats in the 2025-2040 timeframe in an environment in which land, air, maritime, space, and cyberspace domains are simultaneously contested. See http://www.tradoc.army.mil/multidomainbattle/, accessed November 28, 2017.

ing, some systems of the future will be manned or remotely operated, but many, if not most, will be fully autonomous and unmanned. Autonomous weapons, smart mobile sensors, active reconnaissance, and real-time intelligence processing and fusion systems will be present in all domains of warfare (air, land, sea, space, and cyber). Many units will consist of smart agile hybrid teams of people and machines.

As the former Army Chief-of-Staff, General Erik Shinseki, told his commanders, If you dont like change, you are going to like irrelevance even less. The US and its military are not strangers to adaptation and change. To build on this foundation of change, an adaptive approach to operations based on complexity becomes the primary force multiplier for many military operations. Complexity models will enable the force to change to a more desired situation for the operation through the ability to learn and adjust faster than the adversary. The critical step to achieve these new capabilities involves developing a smarter, more knowledgeable, more interdisciplinary, more capable leadership and workforce for the nation and the military. The best way to prepare leaders to deal with change is to help them become smarter (that is, develop their critical thinking skills and ability to solve difficult, multifaceted problems) and more agile (that is, demonstrate mental dexterity and the ability to quickly adapt mental models in dynamically evolving settings). People become smarter through education; people become more agile through training.

3 Education as a Force Multiplier

Education (development of the intellect) is the one critical and viable instrument of national and military power. A country cannot be a leader in the world without smart people who can make wise decisions, solve challenging problems, and build sustaining infrastructure. Smart, dedicated, hardworking and educated people make a country strong and capable. Unfortunately, the US education system of today is marginal, at best, in terms of preparing young people to be effective leaders with mental dexterity, critical thinking skills, and ability to solve complex problems. Moreover, the US education system is deeply bound in a reductionist approach as it attempts to build conceptual understanding of complex phenomena by progressively introducing simplistic explanations of the sub-components of systems. The education system relies on building blocks and operates under the assumption that students cant develop an understanding of complicated issues without first mastering their understanding of the basics. As such, the system reinforces the provision of overly simplistic explanations.

When we use the word simple here, we dont mean to denigrate the contributions of those who have made progress through reductionist approaches. Our view of simple is that somebody has already solved that problem or come up with a reasonable way to solve those types of problems. It wasnt simple for the folks originally confronting those problems. Figuring out how to fight and win the Cold War wasnt easy. It wasnt simple. In retrospect, it looks simple because we figured it out. Just like in math class, you struggle with a problem and cant see the solution until you do and then you wonder how you didnt see it all along. Using the word simple doesnt imply a critique of those who solved those problems. Its just that now our education system tends to work on the assumption that we cant even begin to deal with complex problems until weve mastered simple ones. The approach of our education system is to build up to complexity: we start by asking our students to solve problems that have already been solved and for which we already know the answer. However, the problem with this approach is twofold. One, as we have already discussed, complex systems are often not reducible. Two, young people going through our reductionist education system often get bored, drop out, or are told they cant possibly solve complex problems because they cant solve the simple ones. Many learners recognize the reductionist approach to education as disingenuous and wonder why they need to expend time and effort to master things that have already been mastered.

In todays world, digital generals are as important to national security as military generals, and the military needs people who are both. We need citizens, cities, states, organizations, and our military to possess capabilities in complexity modeling and technical problem solving. Modern science (especially complexity modeling and problem solving) and interdisciplinary learning are often on the margin in US education. There are forward-thinking schools in education-savvy cities and states that set a strong intellectual foundation, but overall, the US is losing the education war. The US economy is shifting to a modern approach but the education system has not kept up. Results from the 2015 of the test issued by the Organization for Economic Co-operation and Development (OCED) to over 500,000 secondary-age students in 72 participating nations as part of the Program for International Student Assessment (PISA) show that the US ranks 40th in mathematics and 25th in science.[3]This level of performance will not be adequate if the US seeks to remain a world leader. As the productivity of the US education system continues to lag, our military dominance potentially deteriorates. Our nation and our military desperately need a boost in education.

4 USMA and her Sister Academies

USMA and her sister academies are national assets that history clearly shows have contributed to the success of the US and the improvement of the world in the past. During the 19th century, USMA served as a national model for undergraduate technical education in America. Established in 1802 as Americas first science-based engineering college, the Academy developed a plan to unite the scientific discussions of the French, with the practical methods of the English: that theory and practice, science and art, may mutually aid and illustrate each other.[4] The plan worked as Academy graduates forged the countrys new scientific culture, established Americas technical education system, and built the nations infrastructure.[5] Secretary of War Peter Porter explained in 1828 that West Points legacy

[3]See PISA 2015 Results from the OECDs Programme for International Student Assessment website at http://www.oecd.org/pisa/, accessed November 27, 2017.

[4]Charles Davies, *Elements of Algebra*, 1835.

[5]See *West Points Scientific 200: Celebration of the Bicentennial, Biographies of 200 of West Points Most Successful and Influential Mathematicians, Scientists, Engineers, and Technologists* by Chris Arney, 16

of scattering the fruits of science not merely to the rest of the Army, but to the youth of our country generally, and the interchange of theoretic science with the practical skill and judgment of our civilian engineers, will soon furnish every part of the country with the most accomplished professors in every branch of civil engineering.[6] By the end of the 19th Century, West Point did all this, and America became the worlds leader in science with West Point graduates leading the effort and contributing to its success. As President Theodore Roosevelt stated on the Academys Centennial Celebration, No other educational institution in the land has contributed as many names as West Point to the honor roll of the nations greatest citizens.[7]

During the 20th century, academy graduates continued to make significant contributions as academic leaders and as military leaders at global levels of strategic interest. Names like MacArthur (USMA 1903), Hap Arnold (USMA 1907), Bradley (USMA 1915), and Eisenhower (USMA 1915) are well known as the men who managed systems of war machines and massive military forces to fight wars. Others contributed by way of producing leading scientific textbooks (Fiebeger, Gordon, Nicholas, Pillsbury, and Yates), supervising major engineering projects including the construction of nuclear power plants (Gribble), and serving as organizational members of influential academic societies (Bartlett, Nichols, and Pettis). Additionally, West Point has consistently been an early adopter of new educational technologies through its mainstream implementation in core academic classes of the slide rule (1944), overhead projectors (1947), mechanical computers (1947), main-frame computer (1958), personal calculators (1975), and personal computers (1985).

The service academies should make a commitment to providing intellectual leadership for the US and its military in the 21st Century and beyond. US taxpayers commit millions of dollars annually to produce high-quality, intellectually talented, dedicated graduates and officers from West Point and the other academies. There are good reasons for this support. The service academies serve as de facto national universities and have been the exemplars of our countrys strength and set the tone for undergraduate education in the US. However, much more is needed in the complex information-based world we live in today. The academies need to deliver much more than capable, successful junior leaders for the military, as they did in the infrastructure-development era (19th century) and imperialism-cold war era (20th century). Todays academy graduates must be able to grow in intellect, wisdom, thinking, and complex problem-solving capabilities to produce the future senior leaders for the nation in the information age (21st century).

March 2002. Those profiled include Alexander Dallas Bache (USMA 1825), the founder and first president of the National Academy of Science; Sylvanus Thayer (USMA 1808), the Father of American Technical Education; Charles Davies (USMA 1815), William Bartlett (USMA 1826), and Edward Courtenay (USMA 1818), prolific textbook authors; George Goethals (USMA 1880), director of the Panama Canal project; and several dozens of graduates from throughout the 1800s who became math, science, or engineering professors, deans, or presidents in a large and representative sample of American colleges.

[6] Porters quotation is found in James Endler, *Other Leaders, Other Heroes*, 1998, p. 11.

[7] *Centennial of the United States Military Academy at West Point, New York*, 2 vols. Government Printing Office, Washington, 1904.

Many leaders in the military and government are graduates of West Point. Talented West Point graduates have had the opportunity to impact and improve the world for over two centuries. It is up to the West Point academic program to prepare its future graduates to develop intellectual talents to make the most of their future opportunities. The service academies academic programs must contribute curricula, pedagogy, and standards to the entire nations education community to build and enhance an educational model that helps the nation fix its educational woes.

Because the environment where military officers perform and serve is demanding and sometimes dangerous, the academic goals of USMA are extensive. The reality of the world, as a complex mix of humans, machines, animals, geography, cities, ports, ships, planes, roads, buildings, nations, businesses, and much more, produces a substantial intellectual requirement for service academy graduates. The problems that future officers will face are unlike any that can be studied in a classroom, yet they contain elements from the problems they study in all their courses. The requirement of this intellectual capacity is why the West Point core curriculum is broad and deep in courses, subjects, ideas, and perspectives. Their military profession requires broadly and deeply educated leaders who have a scholarly foundation in complexity science and a strong dedication to life-long learning. Cadets study information and leadership, social and physical science, body and mind, mathematics and history, geography and language, engineering and humanities, mathematics through computation and meaning in literature. They learn about words and numbers, ideas and devices, people and machines, and war and peace. The environment where they work and the problems they will confront upon graduation are complex. This complexity comes from entity relationships, multiple scales, data size and quality, and multiple and dynamic perspective. The modern world is often nonlinear (not proportional), nonreductive (not dividable), nonergodic (erratic), nonstatic (dynamic), nondeterministic (stochastic), nonsmooth (chaotic), nonscaled (multi-scaled), nonsimple (complex), nonfinite (infinite), nonhomogeneous (diverse), and non-disciplinary (inter-disciplinary, multi-disciplinary, trans-disciplinary, or hybrid). Traditional undergraduate education develops very little of these properties. This must change at the academies. West Point, like all undergraduate schools coping with the dawning of the information age, is in transition to find ways to embrace and teach the complexities and reality properties of the modern world. However, time is of the essence world events do not occur at the slow pace of academic change. USMA and its sister service academies need an all-encompassing paradigm shift from the current state of preparing graduates for 1955 simplicity to the goal of preparing future officer for 2025 complexity.

In some ways, West Point education should be a more advanced program than a foundational, basic-skill, undergraduate program. USMA can become one of the undergraduate schools to lead undergraduate education into the information age. USMA has the benefits of national outreach and recruitment of students who are paid to study and learn, who possess a vested interest in the profession that they will be serving after their graduation, and who study in a facility with tremendous infrastructure and resources. These elements separate the service academies from ROTC programs at other colleges (even those in tier 1 universities). While ROTC is less expensive and can provide leaders who are often just as capable as graduating cadets for the basic entry assignments, USMA-educated officers must also develop deeper intellectual skills for long-term value as future senior leaders for their additional cost.

Intellectual engagement and deep thinking are the hallmarks of a strong, adaptable, forward-thinking, and thoughtful professional leader. The US military needs to instill the role of education, scholarship and intellectual engagement among its leaders. We need more intellectual engagement with cross-disciplinary networks designed to pursue and answer some of the large and vexing problems facing our nation today in the applied areas of military art, military science and professional leadership along with building the foundation for further study through science, literature, engineering, language, computation, and culture. And most importantly, the integration of all these disciplines and concepts into interdisciplinary problem solving skills must occur throughout the four years of cadet education. Military success in future operations rests with the leaders ability to think and adapt faster than the enemy and to operate effectively in a complex environment of uncertainty, ambiguity and unfamiliar cultural circumstances. The very nature of military operations is changing and modeling and inquiry in complexity science build the framework for the nations security community to anticipate and react to those changes. The military needs a community of scholars to shift the paradigm to stay ahead of changing defense issues and needs. Such an effort requires the military to have involvement from all academic disciplines at all levels of thought, while seeking cooperation and collaboration to bring these multiple perspectives to bear on the complex issues that the military will face in its future. USMA and the other service academies need to build their intellectual programs to become the foundations for future military success and models for undergraduate education in America.

5 The Future: Suggestions for Your Course

How do we shed the cognitive constraints and simplicity of Machine Age thinking and learn to apply complexity thinking to future Information Age problems? We start by modernizing and enhancing the academics of our service academies. The academies need to embrace complexity; recruit for intellectual aptitude; inspire their students to engage in deeper and more rigorous problem solving challenges; and fulfill academic leader roles as our nations national universities. Someday in the heat of a crucial operation to secure order in the world, a future Army Chief of Staff will not ask for a West Point football player for a secret and dangerous mission as George Marshall did in 1943, but will request the assistance of a service academy scholar to solve a complex problem that changes the course of history.

A full treatment of how to shape the curriculum to achieve the ends proposed here is beyond the scope of this article. The authors struggle with finding the right approach in their own classrooms for how to enable students to develop the skills required to solve truly complex problems. However, we believe individual instructors can begin to take some very primitive steps toward incorporating the idea of complexity analysis into their classrooms. First, start by asking complex questions. Ask your students to answer questions that have not been answered before. Second, encourage your students to seek insights to these complex questions by drawing ideas from different and multiple disciplines. Model this behavior by collaborating with peers in other departments when developing lesson plans, exercises, and assessment rubrics. Also help your students develop mental models as complex and adaptive rather than static systems. Make the time to have them think through potential second and third order effects. Use models to not only think through the actions of the primary subject but also the interactions of all players actions. Third, inspire your students to engage the material as best as they can. Push them to strive to make progress despite the high probability that you (collectively) are not likely to find a complete and approved solution to the problem during this lesson, this week, or even this semester. Finally, remember that decision-making takes place in a complex, high-dimensional, fractal, fractional, human-relevant world, not a simplified ideal world. As such, attempt to put your students in situations that cause them to act and to inform decision-making processes in the presence of complexity and ambiguity as much as possible while minimizing abstractions to idealized settings.